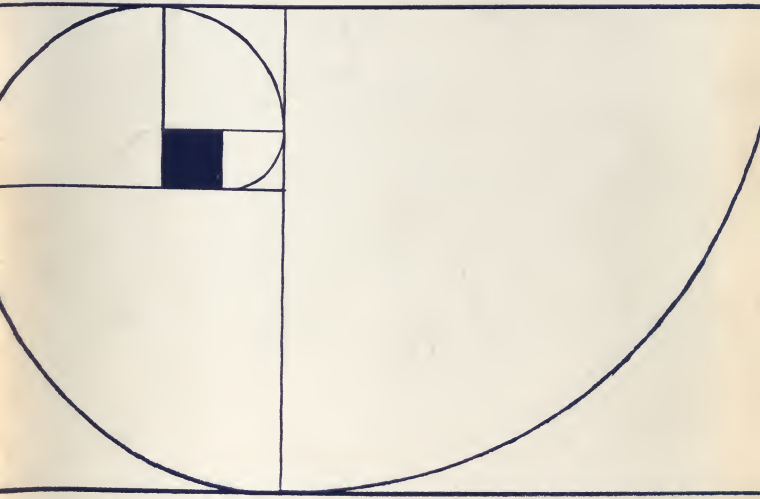
Mecheleciv

VOL. 19 MARCH, 1961 NO. 4

THE GEORGE WASHINGTON UNIVERSITY – SCHOOL OF ENGINEERING

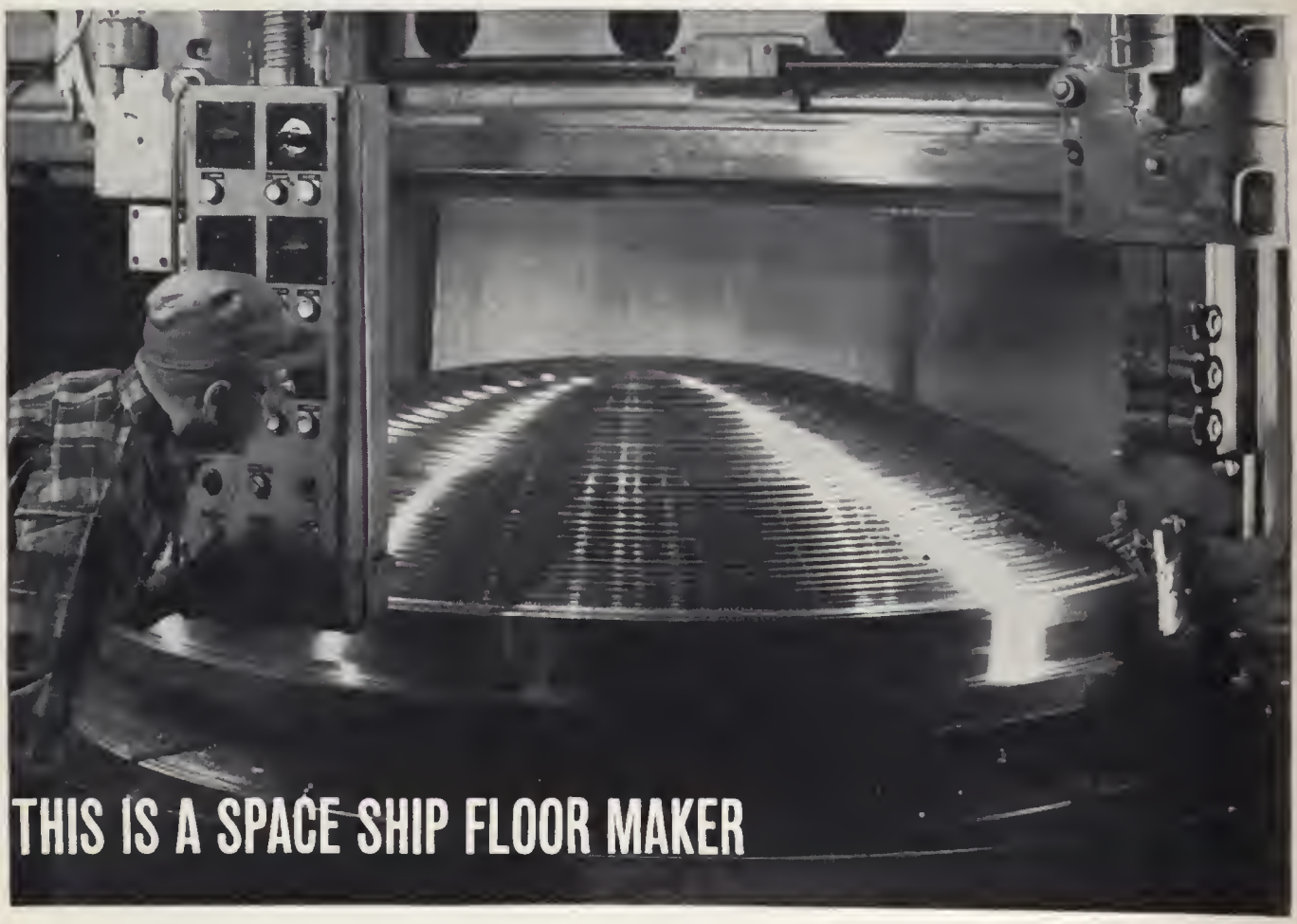


(Cover story on page 7)

THE GEORGE WASHINGTON UNIVERSITY

MARCH 1961

Sometime within the next several years, the first American will soar into orbit around the earth. He will be sealed in a small, cone-shaped space capsule mounted atop an Atlas missile. The missile will climb 100 miles in less than six minutes, where the capsule will disengage and go into orbit. The man will be alone in space.



THIS IS A SPACE SHIP FLOOR MAKER

The vehicle for this historic voyage is already in production under the auspices of the National Aeronautics and Space Administration's "Project Mercury." One of the methods of heat protection is a beryllium heat sink, forged on two giant steel dies. Both dies are USS Quality Steel Forgings. The top die (shown being rough-machined on one of our vertical boring mills) will be convex, 20 inches thick and will weigh 26,520 pounds. The bottom die, concave and 18 inches thick, weighs 27,700 pounds. Both are 92 inches in diameter.

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NASA program-highlights

NEXT DECADE IN SPACE

Year 4 to 14 of the Space Age

Project Mercury—U. S.'s first manned satellite.

Project Surveyor—First soft landing on moon. Conduct observations from stationary position.

Project Prospector—Soft landing on moon and exploration of area within 50 miles of landing point.

Solar Observatory—350 lb. Large flywheel and extended arms rotate to stabilize. Under construction.

Project Mariner—600 to 1200 lbs. First U. S. Planetary missions to Venus and Mars. Modified craft for hard landings on moon.

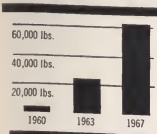
Project Voyager—Orbit Mars and Venus and eject instrumented capsule for atmospheric entry and perhaps landing.

Nimbus—600 to 700 lb. meteorological satellite series. Stabilization system will keep cameras pointed earthward.

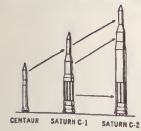
Orbiting Geophysical Observatory—1000 lb. geophysical research satellite designed for a near earth circular polar orbit or an inclined highly elliptical orbit.

Project Aeros—24-hour stationary weather satellite. Launched in equatorial orbit. Three satellites could permit continuous observation of most of earth's surface.

Orbiting Astronomical Observatory—Standardized, 3500 lb. satellite, for several experiments with different scientific sensors and specialized devices.



Anticipated Growth of NASA Spacecraft in terms of weight of individual near earth satellites.



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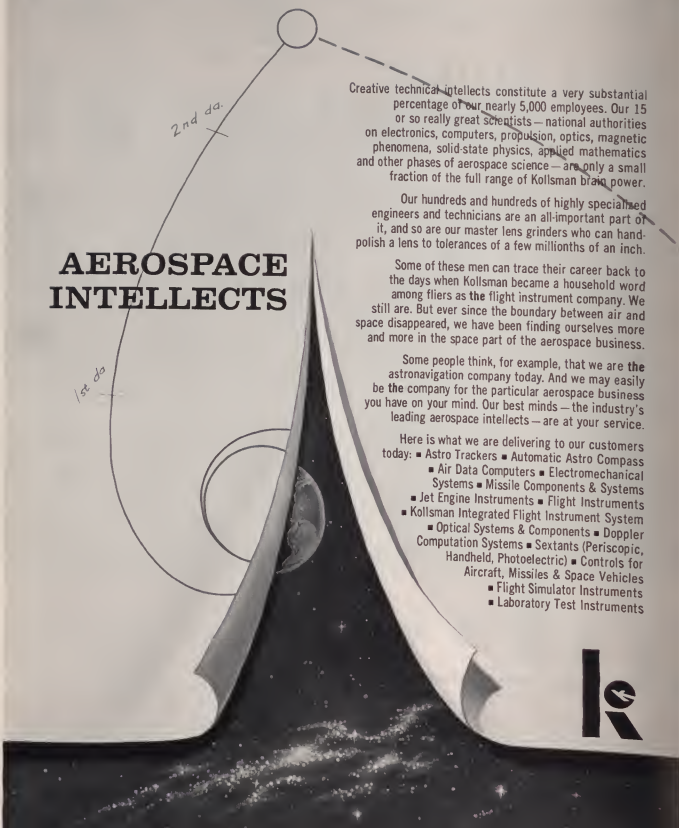

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The Mechelectv

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ARTICLES

DEPARTMENTS

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Editorial Page

GROWTH - Toward What?

Change is all about us today as it has been in every age, some for the better, some but modification, and some for the worse. With change there is passing into limbo for some and growth toward the future for others; obviously not all change is ideally related to passing from the scene or growth toward the future.

The problem for each of us is to know to what purpose we are working and for what we will fight to preserve against change for the worse.

Let us consider our school community in this context. Certainly those who knew our school some years ago are impressed by the changes that have come about in our physical facilities, our curricula, our faculty, and our University. There seems to be wide agreement these have been for the better, and there is feeling that we are growing toward an ill-defined but desirable future. What that future may be we must define.

Shall it be one of more highly able students, housed in more beautiful limestone buildings, and trained in all the most modern concepts of contemporary thought in an environment of sophisticated research and inquiry? Or might it be better one of a group of scholars available to all who truly seek knowledge, housed as may be feasible, and idealistically seeking with their colleagues and students by whatever means the ultimate truth? Or might it best be one of a training school for the profession, couched in the climate of a university, yet devoted to the single purpose of production of highly skilled practitioners?

Our growth and change must be measured and appraised in terms of this future. We must know to what purpose we change and grow else we have no measures for appraisal. This is not our problem alone - it is the problem faced by not only engineers and scientists but by society as a whole. The cold truth is that engineering and science can no longer be ignored as the most significant domain of our age, they affect every aspect of humanity, in fact they are the dominant material in the essential fabric of our society. I believe this fact defines our purpose for us.

For the future I believe we have no alternative but to broaden and strengthen the culture of the student, to continue to insure his competence in the foundations and specialized training of his rapidly changing profession, and perhaps most importantly to impart to those who come to us a knowledge of responsibility to humanity.

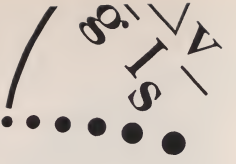
This must be the purpose that guides us and all of our effort must be expended for its realization. It is this purpose that will afford the measures for adoption or rejection of change, the directions for our growth, and the objectives of our instruction. It may require the gradual abandonment of engineering education as it has been and the concurrent development of a new liberal education, in which the dominance of engineering and science in our lives is recognized and observed as well as the importance of those precious areas that have been preserved by humanists at the cost of losing touch with reality.

This is the future toward which we grow.

DEAN MARTIN A. MASON

A GIANT AMONG US

By Thomas B. Wiggins



Like old soldiers, computers never die. However, they don't seem to fade away either. As obsolete machines are replaced by their more powerful and up to date contemporaries, a goodly number serve out the remainder of their useful lives in educational institutions. Such a geriatric specimen is George Washington University's own FLAC II, a really modern "old fellow". Its lineage is impressive.

The Florida Automatic Computers are unique products built by and for the Atlantic Missile Range at the Air Force Missile Test Center, Patrick Air Force Base, Cape Canaveral, Florida. Their sole purpose in being was to assist in the reduction of missile test data, although they are in fact general purpose scientific computers.

At the commencement of testing at AFMTC the computations were performed by SEAC (Standards Eastern Automatic Computer) at the National Bureau of Standards here in Washington, D. C. Since no commercially available machine could handle precisely the data reduction job required by AFMTC, Air Force civil service engineers designed and constructed FLAC I, closely patterning the logic after SEAC. It commenced operation in 1953. The responsibility for its operation was assumed by RCA in 1954 during a reorganization of the Missile Test Center. FLAC I was completely redesigned and rebuilt by RCA in 1955 and 1956, at which time the acoustic delay line memory was replaced by a magnetic core memory. This redesigned machine was then used as a prototype for the construction of FLAC II, with RCA as prime contractor. Since FLAC II began operation in 1957, the two FLAC's have reduced data on 570 actual missile tests and several thousand support tests.

On May 15, 1959, at 11:30 p.m., FLAC II was turned off for the last time at Patrick Air Force Base. Immediately, the engineers began dismantling the computer to make room for an IBM 709 to replace both FLAC's, providing faster reduction of test data. Under the watchful eyes of GWU School of Engineering personnel, FLAC II was crated and shipped to the school by truck.

The computer, on loan from the Air Force for use in bio-medical research at the University, is being installed in Tompkins Hall, Room 100, after a years quarantine on the mezzanine. Physical installation, financed by a grant from the National Science Foundation, is almost complete.

In the early part of July, 1960, FLAC II was moved from the mezzanine. This was no small moving job, since the units were too large and heavy for the freight elevator. FLAC was loaded on a truck at the loading dock and stored overnight on the truck. The next morning the truck returned with a 70 foot boom crane to hoist FLAC through the front doors of Tompkins Hall. An experienced rigging crew moved the units across the marble hallway, through the doors of room 100 and into position without damaging a single part of the computer or the building.

The FLAC installation requires a special elevated floor 17 inches above the existing floor in the room. The air conditioning ducts and all of the electrical connections for FLAC run between the elevated floor and the building floor. This unusual elevated floor can be removed in sections to permit access to any area between the floors.

In order to keep the air free of dust, an electrostatic air cleaner is installed in the air conditioning return ducts. This high voltage (11 KV) unit ionizes the dust and precipitates the particles out of the air.

Here are some vital statistics:

A. The 40 KW of power consumed by the 2900 tubes and 22,000 diodes produces heat that requires 22 tons of air conditioning to dissipate.

B. The 48 binary bit word (or number) consists of 11 sexidecimal digits plus sign plus 3 extra bits used in some of the 16 basic 3 address instructions. The binary point is fixed at the left most end of the number; i.e., the internal numbers are all less than one.

C. The internal transferring of numbers in the machine is serial, meaning the binary bits move through the machine one by one. The arithmetic operations are performed in parallel and the numbers are read out of the 4096 word magnetic core store in parallel into the storage register where they are transferred serially into the machine.

D. The basic pulse rate of the machine, generated by a crystal clock, is 1 megacycle. It takes 50 microseconds to add two numbers and about 2 milliseconds to multiply or divide.

E. Input and output devices include 4 magnetic tape units, 4 punched paper tape readers, 5 paper tape punches, 2 wire recorders, 1 typewriter and 2 ten-bin magnetic tape storage devices capable of storing about one million words with an average access time of one minute to any word.

F. The sixteen instructions which FLAC II can perform are:

1) Addition
2) Subtraction
3) Multiplication (rounded off)
4) Multiplication (precision)
5) Division (unrounded)
6) Logical transfer-logical product
7) Shift
8) Power extract-file
9) Decimal - binary or binary - decimal conversion
10) Tally-jump
11) Algebraic comparison
12) Absolute comparison
13) Equality comparison
14) Read in
15) Read out
16) Search input, output

Probably the most interesting single instruction is the automatic decimal-binary conversion. This is built into the machine and utilizes circuits used in multiplication and addition. Only 1.5% of the total logical circuitry is used exclusively for the conversion process.

The 48 binary digits in the word are arranged in the following manner:

Sign	binary point	number	Logical bits
B_1	•	$B_{45} \ldots\ldots\ldots B_2$	B_{46} B_{47} B_{48} .

A binary number may be represented as

$$(1)\quad N_b = a_1 2^{-1} + a_2 2^{-2} + \ldots a_{44} 2^{-44} ,$$

where a_i may be either zero or one.

This number may also be expressed as

$$(2)\quad N_d = b_1 10^{-1} + b_2 10^{-2} + \ldots b_{11} 10^{-11} ,$$

where b_i may be any value from 0 through 15.

Therefore each digit of (2) corresponds to 4 digits of (1). If the b_i are restricted to values in the range 0 through 9, (2) represents binary coded decimal notation;

$$b_1 10^{-1} = a_1 2^{-1} + a_2 2^{-2} + a_3 2^{-3} + a_4 4^{-4} .$$

Therefore (1) can be expressed as

$$(3)\quad N_d = b_1 2^{-4} + b_2 2^{-8} + \ldots + b_{11} 2^{-44} ,$$

where b_i are restricted to values from 0 through 9 and 2^{-4i} defines the position of b_i.

The conversion process is then accomplished by transferring the first binary coded decimal digit from

$$(1)\quad [\, a_1 2^{-1} + a_2 2^{-2} + a_3 2^{-3} + a_4 2^{-4} \,]$$

to the storage loop where it is stored as b_1 in (3), the decimal representation. These 4 digits are then subtracted from (1), the result normalized (shifted to the left 4 places), and the process is repeated for b_2. And so on to b_{11}, which gives the full decimal number.

Decimal to binary conversion is done a little differently to make use of existing circuitry in the computer. The first step is to form the following partial result from (3) and store it in the storage loop:

$$(4)\quad N' = [\, [\, (b_1 \cdot 10 + b_2)\, 10 + b_3 \,]\, 10 + \ldots b_{11} \,] .$$

N' will not exceed 37 binary bits and since it must be stored as a number less than one, it is stored as

$$(5)\quad \bar{N} = N' \cdot 2^{-37}$$

$\bar{N}$ may also be expressed using equation (4) as

$$(6)\quad \bar{N} = [\, b_1 10^{10} + b_2 10^{9} + \ldots b_{11} \,]\, 2^{-37}$$

The expression in the brackets multiplied by 10^{-11} gives the binary representation as in (2). Therefore it is only necessary to multiply the stored result $\bar{N}$ by $10^{-11}\ 2^{37}$ to get the binary number directly;

$$(7)\quad N_b = \bar{N} \cdot 10^{-11} \cdot 2^{37} = b_1 10^{-1} + b_2 10^{-2} + \ldots b_{11} 10^{-11} .$$

The scale factor $10^{-11}\ 2^{37}$ is actually generated in FLAC II and is used in the normal multiplication circuits to produce the binary number.

The multiplications by 10 required in N' are actually performed by delaying the number. Delaying the number by 1 microsecond is the same as multiplying the number by 2. Therefore, delaying a number by 2 microseconds, adding the original number and delaying by 1 more microsecond gives a multiplication by 10. This is quite a bit faster than the normal multiplication circuitry used in the machine.

This, then, is a brief glimpse at FLAC II. It will be operating in the near future and will provide a much needed service within the University.

WHAT'S NEW

The Science of Measurement

Metrology—the science of measurement. At George Washington University's School of Engineering it will soon be possible to sign up for a degree course in metrology. The equipment shown is the Leeds and Northrup K 3 potentiometer, with Wheatstone bridge. The console at the right is an ac/dc calibrator, also used to check voltages. These are the most accurate instruments of the kind now in industrial use.

By Danny Mulville

Since Noah built his ark three hundred cubits in length, and the Egyptians designed the first pyramid, measurement has been an integral part of the development of mankind. Without measurement the progress of the human race would have been stalemated. Men would have lived in an abstract, dimensionless world. Cities and ships could never have been built. But man did realize the usefulness of measurement, and so civilization progressed.

The need for precision in measurement today varies widely from that of Noah or the Egyptians. While a carpenter may find a metal rule suitable, an aeronautical engineer may require his dimensions in millionths of an inch. This need for more precise measurement, and correspondingly for qualified technicians and engineers in measurement science has increased considerably within the last decade. How can we fulfill these needs and meet this present challenge?

The George Washington University has presented a solution to this problem. The Center for Measurement Science has been established at the University in cooperation with government and industry to provide research, education and service programs for the advancement of measurement technology.

The Center, which is America's first Institute of Measurement Science, was begun in September, 1960 with the financial supoort of the Martin Company of Baltimore and other Associates. These Associates are government agencies, companies, corporate units, or individuals who have an interest in the advancement of measurement science. The Center is a part of the School of Engineering which incorporates facilities of the National Bureau of Standards. The School of Engineering offers four curricula in the field of measurement science, viz., Engineering Technologist Certificate, Bachelor of Science in Engineering, Master of Science in Engineering and Doctor of Science. In addition to the certificate and degree programs the University offers special programs for the benefit of Associate personnel.

The Metrology curricula, which started in the spring semester of this year, includes a fundamental course in metrology, a course on statistics as applied to measurements, and specialized courses such as electronic, thermal and optical measurements. Students specializing in metrology will be required to take about 30 per cent of all their courses in this subject.

"Through this new Institute," said Dean Mason, "America hopes to overcome Soviet superiority in the science of measurement — metrology — which has contributed greatly to Russia's missile and space achievements."

*** COVER STORY ***

As engineers we are all well aware of how often the constants e and π turn up in our everyday measurements and computations involving the physical world. On this month's cover our artist, Jett McNett, has symbollically depicted for us another such natural ratio which, although it turns up quite as frequently as the other two, is perhaps not as familiar to us. This ratio, the so-called "Golden Mean" of 1:1.618, is often found in nature and much used in art. In the pattern of squares of our cover design the successively larger and larger squares form the geometric progression 1,2,3,5,8,... The ratio of one side to the next larger side rapidly approaches the ratio 1:1.618 as the progression is increased; mathematically, in the limit as $\underline{a}$ and $\underline{b}$ both approach infinity, $a:b = b:(a+b) = 1:1.618$. The spiral traced through the squares is the spiral of Archimedes and is the same spiral found in the shell of the chambered nautilus, a deep-sea mollusk. Thus while we as engineers may never be called upon to design a deep-sea mollusk it is well that we should appreciate the orderliness and good design inherent in the natural world from which all our ratios come.

A STRESS ANALYSIS OF A STRAPLESS EVENING GOWN

This article has appeared numerous times in ober engineering magazines. It is reprinted here for your enjoyment and to partially fulfill our promise to offer articles of a civil and mechanical nature. The author is Charles E. Siem of the CALIFORNIA ENGINEER.

Since the beginning of recorded history, the human being has worn some type of clothing either for protection or warmth. However, the present trend among the "fair sex" is to wear clothing not for protection or warmth, but solely to attract the attention of the opposite sex. To be more specific, it is through the use of clothing that the female most effectively catches the eye of the very appreciative but totally unsuspecting male.

A variety of methods are employed to bring about this libido awakening infliction on the poor male. One very popular method employed by the female is to wear transparent, or seemingly transparent, cloth to good advantage in certain areas. A common example of this type of clothing is the transparent nylon blouse. Another powerful attention-gathering device is the tightly fitting garment. A well known example of this type of weapon is the sweater. Yet another provoking method is by actually reducing the amount of body area covered by cloth. A good example of this method is the modern bathing suit. A delightful device which has sufficiently aroused the notice and curiosity of the masculine sex is the use of durable but fragile appearing cloth which gives the impression that at any moment the garment will slip down or that, better yet, certain parts might slip out of place. The best example of this method of attracting the attention of the weak and susceptible male is the strapless evening gown.

Effective as the strapless evening gown is in attracting attention, it presents tremendous engineering problems to the structural engineer. He is faced with the problem of designing a dress which appears as if it will fall off at any moment and yet actually stays up with some small factor of safety. Some of the problems faced by the engineer readily appear from the following structural analysis of strapless evening gowns.

If a small elemental strip of cloth from a strapless evening gown is isolated as a free body in the area of plane A of Fig. 1, it can be seen that the tangential force F is balanced by the equal and opposite tangential Force F. Also the downward vertical force W caused by the weight of the dress below plane A is balanced by the force F acting vertically upward due to the stress in the cloth above plane A. Therefore, since the algebraic summation of vertical and horizontal force is zero, and no moments are acting, the elemental strip is in equilibrium. But consider an elemental strip of cloth isolated as a free body in the area of plane B of Fig. 1. The two tangential forces F_1 and F_2 are equal and opposite as before, but the force W due to the weight of the dress below plane B is not balanced by an upward force F because there is no cloth above plane B to supply this force. The algebraic summation of horizontal forces is zero but the algebraic summation of vertical forces is not. Therefore, this elemental strip is not in equilibrium but it is imperative, for social reasons, that this elemental strip be in equilibrium. If the female is naturally blessed with sufficient pectoral development, she can supply this very vital force and thereby place the elemental strip in equilibrium. If she is not, the engineer has to supply this force by artificial methods.

In some instances the engineer has made use of friction to supply this force. The friction force is expressed by $F=fN$ where F is the frictional force, f is the coefficient of friction and N is the normal force acting perpendicularly to F. Since for a given female and a given dress, f is constant; then to increase F, the normal force N has to be increased. One obvious method of increasing the normal force is to make the diameter of the dress at line C, Fig. 2 smaller than the diameter of the female at this point. This has, however, the disadvantage of causing the fibers along line C to collapse and if too much force is developed the wearer will experience undue discomfort.

As if the problem were not complex enough, some females require that the back of the gown be lowered to increase the exposure and correspondingly attract more attention. In this case the horizontal forces F_1 and F_2 are no longer acting horizontally, but are acting downward at an angle a with the horizontal as shown by T_1 and T_2 of Fig. 1. Therefore, there is a total downward force equal to the weight of the dress below plane B plus the vector summation of F_1 of the two inclined forces, T_1 and T_2. But this vector sum F_1 increases in magnitude as the back is lowered because $F_1=2T \sin a$ and the angle a increases as the back is lowered. Thus the vertical upward force F which has to be supplied for equilibruim is greatly increased

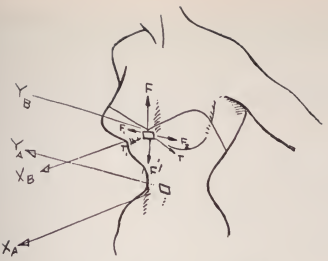


Figure 1—Forces Acting on Cloth Element

for low-back gowns. Also since there is no cloth around the back of the wearer, the force acting through the elemental strip B, perpendicular to the vertical axis of the female, is greatly reduced and it is this force which keeps the evening gown of the lady from falling forward, away from the wearer — attracting attention by this method is considered unfair tactics among females. Therefore, for very low-back evening gowns the engineer has to resort to bone or wire frameworks to supply sufficient and perpendicular forces.

If the actual force supplied is divided by the minimum force that is required to hold the dress up, the resulting quotient defines a factor of safety. This factor of safety should be as large as possible, but there the engineers run into the difficulty of keeping frameworks light and inconspicuous. Therefore, a compromise must be made between a heavy framework and a low factor of safety. With ingenious use of these frameworks, the backs of strapless gowns may be lowered until cleavage is impending. Assuming the female is naturally endowed to supply the vertical force F still leaves the problem incomplete unless an analysis is made of the structures supplying this force. These structures are of the nature of cantilever beams. Fig. 2 shows one of these cantilever beams (minus any aesthetical details) removed as a free-body (and indeed many such beams can be, in reality, removed as free-bodies). Since there are usually two such divided, the force acting on any one beam is F/2. This force is distributed over the beam from A to F of Fig. 2. More exposure and correspondingly more attention can be had by moving the dress line from A toward B. Unfortunately there is a limit stress, P=vertical force F/2, and A=area over which the bearing stress acts, then

$$S = P/A = \frac{F}{2} \cdot \frac{1}{A}.$$

Since F/2 is constant, if the area A is decreased, the bearing stress S must increase. The limit of exposure is reached when the area between B and C is reduced to a value which causes the bearing stress to increase to the "danger point."

A second condition exists which also limits the amount of exposure. The vertical force, F/2, is balanced by a shear force S acting on the area from D to E and by an internal moment M, Fig 2. The moment M causes tension in the fibers of the beams between E and A and compression in the fibers between C and D. As the dress line is moved from A toward B the moment M is increased, thereby increasing the tension and compression of the fibers. The second limit of exposure is reached when the tension and compression stresses in these critical areas reach the "danger point."

Since these evening gowns are worn to dances, an occasional horizontal force F shown in Fig. 2, is accidentally delivered to the end of the beam causing impact loading. This impact loading causes compression in all the fibers of the beam. This compression tends to cancel the tension in the fibers between E and B but it increases the compression in the fibers between C and D. The critical area is at point D, as the fibers here are subjected not only to compression due to moment and impact, but also to shear due to the force S. With the combination of a low, heavy dress and impact loading, the fibers at point D can be stressed to the "danger point."

There are several reasons why these properties have never been determined. For one, there is a scarcity of these beams for experimental investigation. Many females have been asked to volunteer for experiments along these lines in the interest of science, but, unfortunately, there have been no cooperative subjects. Also, there is the difficulty of the investigator having the strength of mind to ascertain purely the scientific facts. Meanwhile, trial and error and shrewd guesses will have to be used by the engineer in the design of strapless evening gowns until thorough investigations can be made.

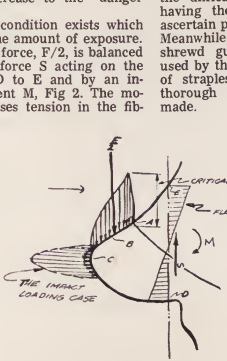


Figure 2—Force Distribution of Cantilever Beam

SOME FUTURES IN ELECTRO-MEDICAL INSTRUMENTATION

By Clifford D. Ferris

The realm of medical electronics is extremely broad and encompasses many fields of interest. Only the more glamorous aspects come to the attention of the layman. One reads in the press, articles on electrocardiography, electroencephalography, heart pumps, artificial organs, x-rays, diathermy, and various other instruments including the recently developed cardiac pacer. This latter instrument is implanted in the chest wall of a patient and supplies the electrical impulses to actuate pumping action of the heart in cases where normal nerve channels are inactive. All of these are the devices which frequently save human lives through early diagnosis of physical defects and tissue degeneration or through replacement of body organs during surgical procedures. Electrical measuring instruments of many kinds are used in medical research. A few examples are spectrophotometers, pH-meters, recorders, data reductions systems and electronic computers, electron microscopes, centrifuges, as well as oscilloscopes, signal generators, and bridges.

Electro-medical instrumentation, however, represents only a small portion of the total activity expended upon advancing medical science by electrical techniques as applied to biology and medicine. There are two other fields of interest in which extensive research is being conducted. One is the study of the electrical properties of tissues and cell suspensions. The other concerns study of the fine structure of body cells. These two fields are closely related. A major problem, at present, is that the nature of body cells is not clearly defined. While much is already known about cell metabolism, there remain many aspects not yet clearly understood. One successful approach to this problem has been based upon electrical measuring techniques. Measurements have been conducted to determine the electrical impedence of body tissues and blood as a function of frequency over the frequency range from one cycle per second to twenty kilomegacycles per second (1 cps to 20 kmc). In essence, one determines the frequency response of the biological material under study. On the basis of the frequency response and associated relaxation times for a given material, an electrical network can be synthesized which generates the empirically determined frequency information. It is then possible to synthesize a mechanical analogue of the electric circuit. Cell structure on the "microscopic" basis can then be determined.

There is much interest in the fine structure of body cells. Microscopic examination of cells reveals many bodies within the living cell. There are, of course, the cell nucleus, chromosomes and associated genes, but in addition there are numerous other smaller bodies. An important class of these are the mitochondria. The cell physiologist would like to know how they affect cell metabolism. Even examination under the electron microscope is not completely satisfactory. Electrical analysis can, however, provide much information.

Electronics engineer and M. D. exchange information as they examine a remotely controlled catheter which may become an important diagnostic instrument in heart disease. Its flexible tip can be "steered" through the pulmonary artery into the human heart's previously inaccessible passageways and cavities.

A word about the nature of electrical impedance measurements is now in order. Three electrical parameters are determined for body tissues and cell suspensions. These are as follows: electrical conductivity, dielectric constant, and permeability. Some rather sophisticated measurement techniques are required to make these determinations over the frequency range specified earlier. Conventional bridge techniques are employed over the range from 20 cps to 50 mc/sec. Special techniques are necessary below 20 cps. and above 50 mc/sec. Unfortunately, so far as measurements are concerned, body fluids are electrolytes. Measuring electrodes become polarized below 1 kc/sec., when conventional bridge techniques are employed, as a result of the current

—Continued on page 16

SIGMA TAU

MECH MISS

Sheila Machlis

Once again one of the six organizations participating in the selection of "Mech Miss" has made its choice. Once again MECHELECIV is proud to present to you a very lovely girl from our university number. She is Miss Sheila Machlis, 20, a sophomore art major from New York City. She hasn't just plain beautiful brown eyes but brown with a touch of green.

Sheila is a member of The University Players and WRGW. Her present interests and future plans are, of course, related to her art major. She enjoys working with practically any phase of the arts whether it be make-up, production, acting, set decorations, music, dancing, painting or whatever. Miss Machlis knows she will eventually find her place among the fine arts, but at present has no particular phase in mind. Sheila isn't all "square" (very obviously) like with the fine arts and all that jazz. Since she works for the electronics section of the Geological Department. Now, how about that!

CAMPUS NEWS

Mr. A. T. Nielson, a member of Theta Tau, presented a student paper to the student chapter of the A. S. C. E. on March 1. His topic was "Photogrametry and Its Application to Civil Engineering".

The A. S. M. E. held its annual student paper competition at the first meeting of the spring semester. Art Macurdy presented a paper on "Uranium Dioxide as a Reactor Fuel Material", and Dirst Sallet's topic was "Nuclear Power in Rockets". A tie for first place was resolved when Art Macurdy volunteered to represent the student chapter of the A. S. M. E. in the Regional Competition at Howard University, March 21-22.

George Titcomb's topic of "Tunnel Diodes" placed first in the I.R.E. - A. I. E. E. student paper competition held on March 1. Also competing in the student paper contest were: Paul Mc Cenny's paper on "Masers", Herb Wilkinson's paper on "Electro-osmosis", and James Kinnahan's topic of "Microwaves". Mr. Titcomb will represent the AIEE-IRE joint student branch at the Regional Competition at the University of Pennsylvania in Philadelphia, April 21.

The AIEE student night was held on March 7 at Catholic University. At the dinner awards were made to Marvin Fox, Most Active AIEE Award; David Lokerson, National AIEE Award; and Donald Lokerson, Washington Section AIEE Award.

Professor Robert Moore is presenting a paper for Jansky and Bailey at the IRE meeting in New York, March 20. Professor Robert Moore is a member of the faculty at the George Washington University, School of Engineering.

The Student-Faculty Committee is considering plans for Engineering Day, which will tentatively be held on a Saturday during the spring semester. High school juniors and their parents will be invited to visit the School of Engineering and discuss college plans with the faculty.

The tentative date for the Engineer's Ball has been set for May 6. Tickets for the Dance may be purchased from members of the Engineer's Council. The cost will be approximately five dollars. Place your order for tickets early to avoid the last minute rush.

Associate Professor Morris S. Ojalvo has been awarded a National Science Foundation Science Faculty Fellowship for the period June - August 1961. This award will enable him to continue his research on Forced and Free Convection Heat Transfer; he will do this at Purdue University in continuation of his doctoral studies and research.

Theta Tau held its initiation and Ball and Banquet on March 18. Seven new members were welcomed into the bonds of brotherhood. The new members are Eliot Cohen, Vance Cribb, Harvey Flatt, Douglas Jones, Jerry Steffel, Clifford Sterns, and John Wolfgang.

Sigma Tau initiated ten new members on Saturday, January seventh last. On the evening of the same day, each new member received his key at a dinner, given in honor of the new members at the Dupont Plaza and to entertain the members, wives and dates. The speaker, Mr. John Armstrong, who is a department head in the Air and Surface Mechanical Research of the Naval Ordinance Laboratory gave a very interesting talk on the various effects of high accelerations.

One of the outstanding features of all Sigma Tau initiation dinners is the horseplay and entertainment provided by the newly initiated members. On this particular occasion, the new members presented the Sweetheart of Sigma Tau and dedicated the following beautifully worded sonnet in her honor:

The girl of my dreams is the best engineer,
in the whole Engineering School
Her shape is square, she wears long hair,
she carries a slide rule
The white of her eyes and the blue of her hair
are the colors of Sigma Tau
If such a girl were, you can be sure she'd be
the sweetheart of Sigma Tau.

The object of this beautiful song, a lovely morsel of femininity, received the song warmly. Her picture is shown so that everyone may see and admire the impeccable good taste in womanhood shown by the Sigma Tau membership.

The Loveliest of Them All — This ravishing beauty is Sigma Tau's idea of what womanhood should be.

The new Sigma Tau members, who were honored by initiation into our Fraternity are:

Harold L. Boerlen
Thomas P. Carroll
Randall C. Kenyon
See Chek Lin
Paul E. Rova
Robert L. Sanborn
Henry M. Tharpe
David K. Trask
Charles L. Whitham
Herbert S. Wilkinson

Needless to say, the dinner was a complete success.

What's it take to make the right connection?

Plenty! Consider the problem. Western Electric manufactures the switching systems which connect some 60-million Bell telephones throughout the U. S. The average call over today's electromechanical system requires 420 relay operations. All together, this interconnecting equipment makes up the heart of what is, in effect, the world's largest machine.

That's where Western Electric and *you* come in. The switching equipment for this "machine" involves an enormous manufacturing job carried on by our plants throughout the country. Because of the size and service requirements involved, we require quality standards far exceeding those of ordinary manufacturing. The size of this job presents an unusual challenge to the engineer who may save the Bell System many thousands of dollars by even a small cost-reduction step.

While today's switching calls for a priority on engineering, tomorrow's will be even more exciting. For even now the revolutionary Electronic Central Office is under field trial and promises to remake the world of telephony. Future Western Electric engineers, working closely with their counterparts at Bell Telephone Laboratories, will concentrate heavily on developing manufacturing methods for this ECO equipment.

Your Western Electric assignments may cover many of our other responsibilities as the world's leading communications manufacturer. Perhaps you'll work on advances in microwave transmission, or even on satellite communications.

Joining Western Electric may well be your right connection.

Opportunities exist for electrical, mechanical, industrial, civil and chemical engineers, as well as physical science, liberal arts, and business majors. For more information, get your copy of "Western Electric and Your Career" from your Placement Officer. Or write College Relations, Room 6105, Western Electric Company, 195 Broadway, New York 7, N. Y. And be sure to arrange for a Western Electric interview when the Bell System recruiting team visits your campus.

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drawn by the bridge through the electrodes. This electrode polarization manifests itself as an (additional) electrical polarization impedance which appears in series with the actual impedance of the material being measured. Corrections can be applied to compensate for this effect, but only down to 20 cps. Unhappily, the polarization impedance varies linearly and inversely with frequency. A special bridge technique has been developed using four instead of two electrodes in conjunction with an electronic bridge to eliminate the effect of electrode impedances.

Special electronic bridges and resonant transmission lines are pressed into service for measurements in the range 50 mc-250 mc/sec. Resonant open-wire (Lecher) transmission lines can be used up to 2000 mc/sec. Above this frequency radiation losses become severe. Resonant coaxial transmission lines may be used up to 6000 mc/sec. For 6000 mc/sec. and above, resonant cavity and waveguide techniques must be employed. Impedance measurements of body tissues over this wide frequency spectrum demand extreme competance in electrical measurement theory on the part of the researcher. Measurements should be repeatable to within 1 per cent.

Once the electrical properties of a biological material (such as mitochondria) have been determined, then the data must be analyzed. Application of electromagnetic theory now enters. Through use of Maxwellian theory, it is possible to determine the molecular structure of the material under study. The dielectric and conductivity data can be related to various configurations of orientable polar molecules. A polar molecule may be considered as an electric dipole. When exposed to an alternating electric field, the dipole aligns itself in the direction of the field. A dispersion range (relaxation effect) is defined when the frequency of the applied field becomes sufficiently high that the dipole can no longer follow field variation. Dispersion ranges and relaxation phenomena can be determined from the electrical impedance measurements. It is also possible to determine the amount of energy required to orient a dipole.

Thus it is possible from measurements of the electrical properties of body tissues and cell suspensions to determine the molecular structure of the material. If, in addition, certain other data, such as viscosity, are known, then estimates of molecular size, net charge, shape, and mass can be made. This information cannot be obtained by microscopic examination.

Medical electronics, then, encompasses the fields of electronics, electric circuit theory, electromagnetic theory, physics (mechanics), biology (cell physiology), biophysics, biochemistry, and physical chemistry. Basic studies conducted with the aid of electrical techniques and phenomena have made possible many of the diagnostic devices currently in clinical use. Blood flowmeters, hematocrits (hemaglobin level meter), bacteria counters, and many other devices are currently under development. Some medical men envision a time in the not-too-distant future when a patient will be subjected to examination by a number of electronic devices. The outputs from the devices will be fed into an electronic computer, from which an IBM card will appear with the most probable diagnosis. Each computer will be connected with every other medical computer in the country (or world) so that every diagnostician will have access to all of the information currently available concerning a given illness.

Illustration courtesy of Grad, Urbahn & Seelye.

Inco Nickel helps give engineers the solution to metal problems in new radio telescope

How do you design a precision instrument that will "see" 33 billion light years into space? This problem was answered by the engineers working on this revolutionary, new radio telescope.

But these engineers faced another challenging problem—*How do you actually build it?* How do you build a telescope as tall as a 66-story building with a reflector so big it could hold six football fields?

How do you build a rotating mechanism that can swing this giant up or down, or sideways, to aim at any spot in the Universe with pin-point accuracy? Just the tiniest amount of wear or distortion in this mechanism could throw the telescope millions of miles off target in the far reaches of space!

Where could they get construction materials tough and strong enough? Nickel gave them the answer! Nickel in steel gave these engineers a material tough enough to maintain precision in the rotating mechanism even under the anticipated 20,000-ton load. And Nickel, to be used in the steel members, gave them the high strength at minimum weight needed to support the giant reflector.

The radio telescope is one of the many developments in which Nickel has solved important problems. Most probably you, yourself, in the near future, will be faced with problems just as difficult. When you are, you can count on Nickel—and the cooperation of Inco—to help get the job done . . . and done right!

If you'd like to get acquainted with Nickel steels, write us for a copy of, "Nickel Alloy Steels and Other Nickel Alloys in Engineering Construction Machinery." Educational Services, The International Nickel Company, Inc., New York 5, N. Y.

INCO

International Nickel

The International Nickel Company, Inc., is the U. S. affiliate of The International Nickel Company of Canada, Limited (Inco-Canada)—producer of Inco Nickel, Copper, Cobalt, Iron Ore, Tellurium, Selenium, Sulfur and Platinum, Palladium and Other Precious Metals.

TECH NEWS

By Marshall Levitan

Missile-Squatting Woodpecker Evicted by Canaveral Countdown for the Bird

Missilemen commonly refer to their rockets as "birds," but only the Douglas launch team on Pad 17 B at Cape Canaveral can claim to have launched a real, honest-to-goodness, genuine bird.

The bird, a stubborn, redheaded woodpecker persisted in hammering away at an electrical cable assembly high on the umbilical mast at 17B. Its perforations of the styrofoam and aluminum tape covering the cable alarmed Douglas engineers, so they tried to rout Mr. Woodpecker.

But the woodpecker ignored such traditional bird-scaring devices as shouts and stones. Then the missilemen tried more sophisticated techniques, such as sounding a loud horn which they fastened on the mast, or chilling the cable with carbon dioxide.

Finally, in desperation, they put together a "countdown manual" and prepared to launch the bird "missile-style."

A high-pressure air bottle was attached to the mast near the intruder's latest excavation attempt, and a lanyard was extended to the deck of the launch pad.

With the arrival of the woodpecker, the countdown began . . . 10 seconds . . . 9-8-7-6-5-4-3-2-1-zero . . . WHAM." Up went the woodpecker, tumbling slightly. In a somewhat startled fashion, it straightened out, and, wavering somewhat, flew slowly away, never to return.

Project Redheaded Woodpecker was a success.

Transverse Tester for Concrete

Transverse testing machines in determining the flexural strength of concrete specimens are now available from Steel City Testing Machines, Inc., Designated Model TF-179, the bench-mounted testers have a capacity of 2000 pounds. They apply a uniform load at a pre-set rate, which can be varied to suit different requirements. For flexural tests conforming to ASTM Standards, the load is set at 600 pounds per minute.

The testing machines are hydraulically operated, with the hydraulic system located within the base, and powered by 1/6 H.P. motors operating on 110 volt, 60 cycle alternating current. Simple controls are conveniently located on the front of the base for ease of operation. A flow-control and check valve, with vernier graduated dial, is provided for pre-setting the load rate, and a directional valve for controlling vertical movements. Twin gauges are mounted on the testers for increased sensitivity, one gauge being graduated from 0 to 600 pounds, and the other, from 0 to 2000 pounds. Both gauges are protected against overloading.

Specimens are supported by two lower fulcrums, consisting of 3/8-inch diameter rollers spaced 119 millimeters apart on centers. The centrally-located, adjustable upper fulcrum is also a 3/8-inch diameter roller. One of the lower fulcrums and the upper fulcrum are arranged so that they can pivot.

The compact transverse testers have an overall height of only 31 inches, a depth of 23 inches, and a width of 16 inches. The shipping weight is approximately 240 pounds.

Russians to Warm Arctic

Soviet scientists reportedly have a plan to defrost the Arctic. The Russians think it feasible to thaw a northern sea route through the ice by means of a space belt of potassium particles which would act as a giant reflector for the sun.

Construction Balloon

A military contractor in Wyoming encloses work areas with a nylon balloon to keep his construction crews working on the worst winter days. The inflated balloon measures 100 by 60 by 30 feet, and includes a 12 by 12 by 25 foot air lock for truck entry and a small personnel air lock. A one-and-a-half horsepower fan supplies air to keep the balloon inflated.

Starting Salaries

The following are monthly salaries accepted by this year's college graduates on a national level: chemical engineering, $525; civil engineering, $489; electrical engineering, $536; mechanical engineering, $519; natural sciences, $460; physical sciences, $521. Note that these are

—Continued on page 20

This steel plant consumes 1/400th of the electric power generated in the United States

Surprising? Not if you realize that steelmaking requires a tremendous amount of electric power.

It takes about 20,000 electric motors to drive the rolling mills and other equipment at our Sparrows Point Plant, near Baltimore, the nation's largest steelmaking plant. Here, at our own steam-electric generating station, we produce enough power for a city of 250,000.

It goes without saying that we need the services of electrical engineers to design, construct, and maintain the vast and complicated array of electrical equipment at our many plants and facilities.

Bethlehem offers excellent career opportunities for men in virtually all engineering curricula: *metallurgical, mechanical, chemical, industrial, civil, mining, ceramic, architectural, and others. We suggest that you discuss Bethlehem with your Placement Officer. And be sure to pick up a copy of our booklet, "Careers with Bethlehem Steel and the Loop Course."*

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Steel *for Strength . . . Economy . . . Versatility*

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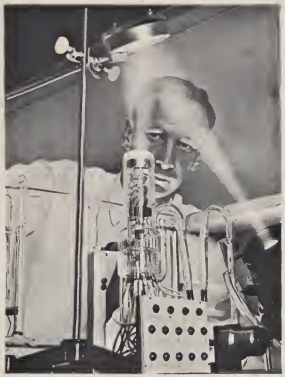
average figures. This information, as well as a further detailed analysis of the survey, is in the October issue of the Journal of College Placement.

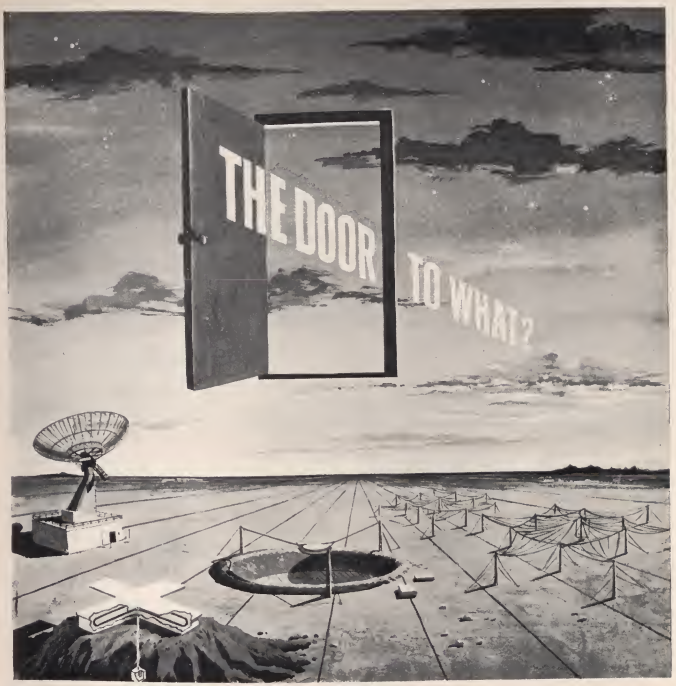
PHOTOMULTIPLIER ION GAUGE



Scientists of Westinghouse Electric Corporation recently devised a laboratory tool for the measurement of pressures less than one-thousandth of one-billionth of the atmospheric pressure at the earth's surface. The device focuses a beam of ultraviolet light which stimulates the metal surface to release electrons. These electrons are guided onto a series of similar surfaces which multiply the electrons in speed and number. The electrons are then used to form ions that are collected and counted. The series of surfaces which release the electrons and increase their number is called a photomultiplier, from which the name of the new pressure-measuring instrument is derived.

RUSTING OF IRON

A new explanation for the rusting of iron has been advanced by the Westinghouse Research Laboratories. The research workers have suggested that it is not the water vapor that actually cause rust, but that the water vapor donates hydrogen ions to the iron and that these protons penetrate the iron and enlarge the sites at which oxygen normally combines with iron. To complete their studies, the scientists made use of an electron microscope that could magnify up to 300,000 times. The photograph is that of tiny blades of rust which are not more than 300 millionth's of an inch high.



Stepping boldly across new thresholds, DECO pioneers in:

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- **Substrata communications**
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- **"Lithocom"**
- **Space communications**

Through this open door to previously unexplored frontiers, DECO proudly contributes to the nation's advancement in communications technology with these recent achievements: *Communications Moon Relay* (NAVY) . . . . *Tapered Aperture Horn Antenna* (TAHA) (ARMY SIGNAL CORPS) . . . . *VLF Radiation System* (NAVY), *World's Largest Transmitting Facility* . . . *World's Largest Radio Telescope* (PUERTO RICO) (CORNELL U.—AIR FORCE).

For participation in advanced projects, qualified engineers are invited to write DECO Director of Technical Personnel, Fort Evans Road, Leesburg, Va. For further information about DECO capabilities write for our brochure.

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Sikorsky Aircraft is the company which *pioneered* the modern helicopter. Our current program is far-ranging and is recognized as one of the broadest and most challenging in the entire aircraft industry.

Work associations are stimulating and in an atmosphere of progress. Assignments could include joining an *electronic* team of twenty to thirty associates—or—working with a highly selective group of four or five on interesting problems of *radiation, instrumentation, auto pilotage, automatic stabilization,* etc.

If you want to enter this *"stream-of-action"*, the time is *now*. Opportunities for personal progress have never been greater.

For detailed information about careers with us, please write to Mr. James L. Purfield, Employment Supervisor.

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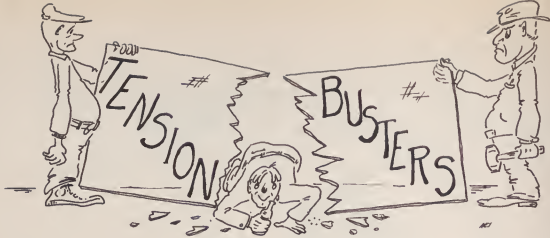

Then there's the story of the battered young lady who told all the details to the young ambulance driver. Her date had beaten her up, pushed her down a flight of stairs, and kicked her where she lay. She described this gallant young knight in detail. "We'll have him picked up in no time," promised the attendant," and the police will put him behind bars." "No, no, don't do that," protested the girl weakly. "Just find him. He promised to marry me."

***

The girls who wear those skimpy bathing suits may not have any particular end in view but they almost do.

***

Mother: "Junior, you've got to quit using such bad words."

Junior: "But Mother, Shakespear uses them."

Mother: "Well then, you can't play with him any more."

***

Two Irishmen recently arrived in America, were doing a little St. Pat's day celebrating. During the conversation, Pat said, "Sure and 'tis an unthankful country this is now. We Irish have done a lot for the United States, and faith and they've named only one state after an Irishman!"

His friend Mike looked puzzled. "Sure and I didn't know there was even one."

"The back o'me hand to you," boomed Pat. "Haven't you heard of that great western state called O'Regon?"

***

Inquisitive woman: "Pardon me, sir, what kind of a uniform are you wearing?"

Serviceman: "I am a naval surgeon."

Woman: "My how you modern doctors specialize."

***

Hostess at a birthday party: "I'm afraid that your little brother is shy. He hasn't moved from that one place all afternoon."

Little girl: "He's not shy. He's never had a necktie on before and he thinks he's tied to somethin'."

Strip Poker—A game in which the more you lose the more you have to show for it.

***

Farmer Jones' son was off to college. When he was completely broke he wrote home for money asking for 100 dollars. Two days later he received a letter. "I'm sending you the money as requested but am surprised that a college student doesn't know that ten dollars is written with one zero instead of two."

***

A fine is a tax you pay for doing wrong, while a tax is a fine you pay for doing well.

***

Cocktail party chatter: "Don't take another drink, honey. Your face is getting blurred."

***

"Dad, Mom just backed the car out of the garage and ran over my bicycle!"

"Serves you right for leaving it on the front lawn!"

***

He walked her to the front door.

She whispered with a sigh, "I'll be home tomorrow night."

He answered, "So will I!"

***

The local village council was deciding whether or not to erect a statue to the memory of the wealthy but much-hated squire. It came as a surprise when a popular councillor spoke in favor. He added... "The statue will give shade in summer, shelter in the winter—while the birds can be trusted to express the opinions of most of the villagers!"

***

A young couple was preparing to elope.

"Shall I wear my wool dress or my chiffon dress, darling?"

"It doesn't really matter dear, I'll love you through thick and thin."

***

The Democrats had a mock convention the other week and even Perle Mesta was there. She was parking cars.

Grandpa and Grandma Hickey recently celebrated their Golden Wedding Anniversary by taking a second honeymoon. They decided to go to all the same places and do all the same things that they did when they took their first honeymoon.

Upon their return, a friend asked Grandpa all about the trip.

"Never had a better time in my whole life, except for one thing."

"And what was that?" asked the friend.

"This time it was me who went into the bathroom and cried," replied Grandpa.

***

A travel magazine says that in some parts of Africa, women wear long hair and no clothing.

Over here they wear short hair.

***

"Henry," said his nagging wife, as he got ready for bed, "is everything shut up for the night?"

"Everything else is," Henry muttered.

***

Said the caller: Madam, I'm representing the Goat Mountain Wool Company. Would you be interested in some yarns?"

Housewife: "Sure, go ahead; let's hear a couple!"

***

Excerpt from a sailor's letter from the South Seas: "Long time no she."

If your sights are set on space survival–

Scientist photographs the development of experimental "lunar" plant at the Republic Aviation Corporation's "Lunar Garden."

–you'll find **Photography at Work** with you

Solving the problems of a human being living in outer space has become the task of scores of engineers, chemists and botanists. And serving them as a valuable working tool is photography. It records the growth of experimental plants and fungi that can well become the space voyager's food supply. Through autoradiography it can show the absorption of cosmic radioactive material, trace its circulation within the organism.

There's hardly a field on which you can set your sights where photography does not play a part in advancing work and simplifying routine. It saves time and expense in research, on the production line, in the engineering and sales departments, and in the office.

So in whatever you plan to do, take full advantage of all the ways photography can help.

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With photography and photographic processes becoming increasingly important in the business and industry of tomorrow, there are new and challenging opportunities at Kodak in research, engineering, electronics, design, sales, and production.

* * *

If you are looking for such an interesting opportunity, write for information about careers with Kodak. Address: Business and Technical Personnel Department, Eastman Kodak Company, Rochester 4, N.Y.

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Kodak
TRADE MARK

One of a series

Interview with
General Electric's Byron A. Case
Manager—Employee Compensation Service

Your Salary at General Electric

Several surveys indicate that salary is not the primary contributor to job satisfaction. Nevertheless, salary considerations will certainly play a big part in your evaluation of career opportunities. Perhaps an insight into the salary policies of a large employer of engineers like General Electric will help you focus your personal salary objectives.

Salary—a most individual and personal aspect of your job—is difficult to discuss in general terms. While recognizing this, Mr. Case has tried answering as directly as possible some of your questions concerning salary:

Q Mr. Case, what starting salary does your company pay graduate engineers?

A Well, you know as well as I that graduates' starting salaries are greatly influenced by the current demand for engineering talent. This demand establishes a range of "going rates" for engineering graduates which is no doubt widely known on your campus. Because General Electric seeks outstanding men, G-E starting salaries for these candidates lie in the upper part of the range of "going rates." And within General Electric's range of starting salaries, each candidate's ability and potential are carefully evaluated to determine his individual starting salary.

Q How do you go about evaluating my ability and potential value to your company?

A We evaluate each individual in the light of information available to us: type of degree; demonstrated scholarship; extra-curricular contributions; work experience; and personal qualities as appraised by interviewers and faculty members. These considerations determine where within G.E.'s current salary range the engineer's starting salary will be established.

Q When could I expect my first salary increase from General Electric and how much would it be?

A Whether a man is recruited for a specific job or for one of the principal training programs for engineers—the Engineering and Science Program, the Manufacturing Training Program, or the Technical Marketing Program—his individual performance and salary are reviewed at least once a year.

For engineers one year out of college, our recent experience indicates a first-year salary increase between 6 and 15 percent. This percentage spread reflects the individual's job performance and his demonstrated capacity to do more difficult work. So you see, salary adjustments reflect individual performance even at the earliest stages of professional development. And this emphasis on performance increases as experience and general competence increase.

Q How much can I expect to be making after five years with General Electric?

A As I just mentioned, ability has a sharply increasing influence on your salary, so you have a great deal of personal control over the answer to your question.

It may be helpful to look at the current salaries of all General Electric technical-college graduates who received their bachelor's degrees in 1954 (and now have over 5 years experience). Their current median salary, reflecting both merit and economic changes, is about 70 percent above the 1954 median starting rate. Current salaries for outstanding engineers from this class are more than double the 1954 median starting rates and, in some cases, are three or four times as great.

Q What kinds of benefit programs does your company offer, Mr. Case?

A Since I must be brief, I shall merely outline the many General Electric employee benefit programs. These include a liberal pension plan, insurance plans, an emergency aid plan, employee discounts, and educational assistance programs.

The General Electric Insurance Plan has been widely hailed as a "pace setter" in American industry. In addition to helping employees and their families meet ordinary medical expenses, the Plan also affords protection against the expenses of "catastrophic" accidents and illnesses which can wipe out personal savings and put a family deeply in debt. Additional coverages include life insurance, accidental death insurance, and maternity benefits.

Our newest plan is the Savings and Security Program which permits employees to invest up to six percent of their earnings in U.S. Savings Bonds or in combinations of Bonds and General Electric stock. These savings are supplemented by a Company Proportionate Payment equal to *50* percent of the employee's investment, subject to a prescribed holding period.

If you would like a reprint of an informative article entitled, "How to Evaluate Job Offers" by Dr. L. E. Saline, write to Section 959-14, General Electric Co., Schenectady 5, New York.

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